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Program Information Notice

Division of Electric Energy Systems

Assistant Secretary for
Energy Technology
U.S. Department of Energy

June 1978

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DIVISION OF ELECTRIC ENERGY SYSTEMS

PROGRAM INFORMATION NOTICE

Purpose

This program information notice is prepared and disseminated on a periodic basis to keep interested organizations and individuals informed on the Division's progress in research and development specifically concerned with the nation's electric energy system.

Re-organization

Previous Notices have been published under the U.S. Energy Research and Development Administration (ERDA). On October 1, 1977, ERDA was absorbed into the new U.S. Department of Energy (DOE) and the EES Division now reports to the Assistant Secretary for Energy Technology.

Objectives

The Division of Electric Energy Systems (EES) has as its primary concern those technologies which are relevant and applicable to the systems aspects of U.S. electric energy systems. EES is developing a broadly based R&D program in electric energy system technologies, one which addresses both near-term and longer range needs. The current EES program includes power delivery and power supply integration.

This division has a somewhat special character within DOE. It is the only program division which specifically takes the systems approach to the electric energy network. EES fulfills an important need for tying together the energy source and end-use electric energy technologies. By specifically addressing this need for a systems-oriented R&D program focus, the EES Program seeks to meet the broad objective of ensuring that the national electric energy system is capable of meeting future demands reliably, with greatest efficiency, and within environmental and other constraints.

The nation's energy system does a remarkably good job of meeting the demands placed upon it. So good, in fact, that we tend to take its performance for granted. However, the capability which has resulted in this performance record is more evolutionary than the result of a national electric energy systems planning effort. It would be both risky and unwise to trust evolution alone to develop an electric energy system for the future that will be able to meet these growing, changing, and complex requirements. This is particularly true when we note that some of the potential new sources for the future have inherent characteristics which will make the integration of these into the electrical network extremely complex.

In any new technology development, there is a potential danger that the ultimate device and the system into which it must interact will not properly match. If integration strategies are properly mated, success is much more likely. As one part of its mission, the EES program addresses itself to this issue.

The broad overall objective of the EES Program is to ensure that the Nation's electric energy system is capable of meeting future demands reliably, with the lowest practicable energy losses, with maximum energy conservation, and in accordance with environmental and National Energy Policy (NEP) principals and policies. To this end, the EES Program focuses on R&D designed to:

- Ensure that all of the elements of future electric energy systems (oil, coal, nuclear, solar, storage, fuel cells, conservation, etc.) are integrated as required to achieve an overall energy-efficient system.

- Ensure the continued availability of the system's capability of delivering electrical energy from the source to the user as needed.

- Develop the system design and control techniques that will be required to maintain reliability as the system increases in size and complexity.

- Accelerate the commercialization of emerging technologies with significant near-term energy benefits.

- Meet the need for electric energy systems input for national energy policy planning.

Environmental and socioeconomic considerations are central to this R&D effort.

Program Strategy

EES program strategy consists of assessing the near- and long-term research needs of electric energy systems, keeping informed on the type and amount of research being performed by others, and conducting the RD&D necessary for implementation of specific technologies on a regional or national basis.

While there are some distinct differences, the equipment manufacturers, the Electric Power Research Institute (EPRI), the utilities, and DOE have overlapping involvements in the broad task of electric energy systems development. Detailed discussions of program plans are carried out with EPRI, utilities, and electric utility task forces to minimize the amount of overlap and bridge the gap between research needs and research and development efforts.

EES involvement is focused on expediting the development of higher risk, long-term payback technologies and development of technologies which have a significant potential for enhancing the implementation of national energy policy. Thus, EES support of RD&D ranges from totally funding efforts in longer term payback areas such as superconducting transmission, to sharing the costs of reducing the technological impediments to nearer term system components.

Each cost-sharing arrangement is negotiated on the basis of risk assessment, national or regional need versus individual utility system need, relationship of the technology in question to other DOE efforts, etc. The competitive procurement process is used as an aid in determining the extent of DOE funding participation.

National Laboratories (NL) have been given the responsibility for managing several efforts, and additional management responsibility will be transferred to the field in FY 1978. Utility systems are also engaged in managing a number of projects. These include the operation of the Battery Energy Storage Test Facility (Public Service Electric and Gas Company) and the 4.8 MW Fuel Cell Power Plant (Consolidated Edison Company), as well as other important but relatively less expensive projects such as field tests of alternative communications system, automatic generation control, etc.

EES is working with other DOE divisions in a number of areas. For example, EES is interfacing with the Solar, Geothermal, Storage, Fossil, and Nuclear divisions on the integration problems facing their technologies. EES is also supporting the efforts of the Economic Regulatory Administration and the Federal Energy Regulatory Commission. The program also interfaces with other Federal agencies (EPA, DOD, NRC, DOA) as well as other national and state agencies. There is a protocol agreement with the Soviet Union establishing cooperation in superconducting power transmission development.

Projects

Information on specific R&D projects, both current and planned, is given in the following format:

Contractor (or Title) ID Number (or RFP)

Performance Period Total DOE Funds

Project Summary

Inquiries

Inquiries should be addressed to Director, Division of Electric Energy Systems, U.S. Department of Energy, 20 Massachusetts Avenue, N.W., Washington, D.C. 20545.

EES Program

The EES Program is composed of two major Subprograms, each with a number of programmatic areas. The Subprograms are listed as follows:

Power Delivery

Power Supply Integration

The Subprograms will be discussed separately.

Power Delivery Subprogram

Overview

The EES program for Power Delivery includes the research, development and technical demonstration of advanced transmission and distribution technologies. It also includes the R, D and D on advanced generator technology which is closely associated with basic research efforts in transmission - cryogenics, dielectric materials, lower magnetic loss material, etc.

Subprogram Activities

The EES Subprogram on Power Delivery is formatted into five activities. A description of the projects under each activity, including a brief statement of objectives, follows:

1. Underground Transmission

High capacity and high voltage underground power transmission systems will receive increased attention as the use of overhead lines becomes less acceptable because of aesthetic, social, or local policy reasons, increasingly so in urban and growing suburban areas. EES efforts during the 1979-1984 time period will be focused on the development of compressed-gas insulated cable systems and ac superconducting transmission.

National Bureau of Standards -ID# 6010/A057

12/77 - 11/80 $ 97,500 (current year)

Develop apparatus and appropriate procedure for optical measurements of electrical field distribution and space charge density in materials for electrical power equipment and systems. Understand interfacial processes in selected insulating systems involving multiple dielectrics.

Phelps Dodge Cable & Wire Corp. -ID# T4052

24 months $ 177,600

Development of a unified theory for the mechanism of water tree growth in polymeric high voltage cable insulation and correlation of the theory with experimental results.

Underground Electric Power Transmission Systems Environmental Impact Study -ID# 2852

To investigate and assess the environmental impact of cable systems which were not addressed in previous work and to update previously reported cable system with regard to higher capacity systems which have been identified since 1974. Cable systems will include both ac and dc types of the following:

1. Superconducting
2. HPOF above 500 kV (self and forced cooled)
3. CGIT Flexible, rigid, 3 in 1
4. Glass Insulated

Fault Detection/Location Techniques -ID# 2867

Develop techniques and/or instrumentation system for detecting incipient faults and locating degradation site(s) in various underground power transmission cable systems.

Rensselaer Polytechnic Institute -ID# 4610

1/78 - 3/80 $ 160,000

Development and verification of a mathematical model for laminar synthetic pipe type cables which will allow prediction of tape motions and responses as a result of thermal cycling of the cables.

Brookhaven National Lab. -ID# 16-9

10/77 - 9/78 $ 450,000 (Current Year)

Develop polymeric tapes specifically tailored for use as dielectric insulation on underground power transmission cables, both room temperature and superconducting types.

Brookhaven National Lab. -ID# 16-7

7/73 - 9/84 $2.550,000 (Cu rent Year)

Develop an underground superconducting power transmission system which is economically and technically attractive to the utility industry. The project includes management of all supporting research on materials and refrigeration.

General Electric Co. -ID# 5087

10/77 - 2/79 $ 735,000

Perform a viability evaluation of the flexible resistive cryogenic power transmission cable system to demonstrate its technical and economic competitiveness to alternative transmission systems.

Arthur D. Little, Inc. -ID# 5043

10/77 - 1/79 $ 272,000

Identify the energy required to produce the various raw materials utilized in power transmission lines and the determination of the energy required to manufacture the different transmission designs.

Westinghouse Electric Corp. -ID# 5041

11/77 - 8/78 $ 74,164

Assess the barriers and incentives for using sodium conductor distribution cable. The assessment will consider environmental, safety, energy conservation and economic factors.

Battelle-Columbus Laboratories -ID# 5010

9/77 - 9/81 $2,732,865

Development of an understanding of insulation aging characteristics of solid dielectrics used for underground transmission cable systems. Development and verification of a short term cable test procedure which will accurately predict insulation life for its rated service.

Massachusetts Institute of Technology -ID# 2295/19

8/76 - 12/79 $ 437,256

Compressed gas dielectrics will prove to be increasingly more important for substation and transmission line applications in electric power systems. In order to exploit the technical and economic advantages of compressed gas dielectrics, the insulation system must demonstrate high operational reliability. The focus of the research is on performance under ac and dc voltage, effects of contamination, solid insulating surface behavior, and basic discharge mechanisms in gases.

Systems Control, Inc. -ID# 2079

1/76 - 4/78 $ 206,516

Development of a software program capable of determining the real-time capacity of a 138 kV self-cooled HPOF cable system under various conditions and to validate this program using laboratory techniques and information collected in the field.

Power Technologies, Inc. -ID# 2078

3/76 - 12/78 $1,088,970

Development of a glass insulated underground transmission cable system. Evaluate the technical and economic qualities of the system.

Westinghouse Electric Corp. -ID# 2061

6/75 - 6/78 $1,140,574

Design, develop, test, and provide economic analysis of a prototype UHV (1200 kV) compressed gas insulated cable system.

Los Alamos Scientific Laboratory -ID# 36-4

10/77 - 9/79 $ 165,000

Development of a new technique for non-destructive testing of electric fields inside solid dielectrics. The technique is based on local compressions of the medium under consideration, by a single acoustic pulse of large amplitude.

Philadelphia Electric Co. -ID# 2055

6/75 - 6/78 $ 303,167

Evaluation of the economical and technological viability of various underground transmission systems for long feeds to urban load areas.

Hughes Research Lab. -ID# 1403

5/77 - 6/79 $ 574,939

Determination of the technical feasibility of using a Hughes "crossed field interrupter" tube as a viable mechanism for protection of SF_6 insulated power devices.

Westinghouse Electric Corp. -ID# 2870

3/78 - 9/81 $2,002,875

Develop, manufacture and test a 60 Hz, 1200 kV semi-flexible compressed gas insulated electrical power transmission cable system.

Particle Effects Elimination -ID# 3029

Elimination of the adverse effects of particles (contaminants) in gas insulated transmission systems, through the development of improved equipment and methods so that the excellent gas dielectric properties are fully exploited. Such developments must be practical, economical and efficient.

Phelps Dodge Cable and Wire Corp. -ID# 1482

4/72 - 10/78 $ 294,816

Design and development of an 800 kV synthetic cable. When completed this project will provide the industry a means of undergrounding required 765 kV transmission lines (joint project with EPRI).

Naval Research Lab. -ID# 2897

4/78 - 4/82 $ 245,000

NRL will handle the detailed management of the EES program taking place at Battelle-Columbus Laboratories on the study of the Aging Process in Solid Dielectric Cables.

National Bureau of Standards -ID# 6010/63

10/77 - 10/80 $ 280,000

Evaluate proposals and monitor research projects relative to incipient fault detection and location techniques and/or instrument system for underground transmission systems.

Ion Physics, Co. -ID# 3001

3/78 - 2/81 $ 763,000

Design, manufacture, test, deliver a 230 kV extruded radiation cross-linked polyethylene cable.

Battelle Pacific N.W. Lab. -ID# 1830-16

4/78 - 4/79 $ 410,000

This project is initiated to compare bulk electric energy delivery systems composed of alternative energy conversion and transportation systems on the basis of: system economics, energy transmission efficiency, system environmental impact, and natural resource requirements. The scope of this project will address electric energy systems at the 10 GW power level and employ technologies expected in the 1985-2010 time frame.

Novel Transmission Concepts -ID# 2887

Investigate the technical and economical feasibility of novel concepts for the transmission of electrical power so as to provide additional efficient, reliable, low cost, and environmentally acceptable options for future national needs. Concepts to be investigated will include those which are considered promising but have not received detailed R&D attention. Thus, microwave, electron beam, and other advanced electric power transmission concepts are anticipated to be proposed.

Bechtel National, Inc. -ID# 2851

4/78 - 1/79 $ 92,200

To plan and conduct a workshop that will culminate in recommendations for activites (contracted and otherwise) to increase the efficiency, reduce the time, reduce labor requirements, and simplify procedures of underground transmission cable installation and maintenance techniques.

Cable Technology Laboratories -ID# 3062

26 mos.

Development of a physical model of voltage aging of solid dielectrics used for high voltage underground transmission cable systems, assuming that partial discharge is a prime mechanism for voltage aging. Development of a procedure for a short term voltage test on solid dielectric full reel cables for verification of partial discharge threshold and validation of the procedure.

Field Validation of Cable Monitoring and Rating System -ID# 3122

To validate the cable monitoring and rating system (CMARS) software and hardware on an operating utility.

2. Electric Field Effects

The use of high voltage transmission facilities has raised questions about possible adverse biological and psychological effects of strong electric fields. In concert with the Bonneville Power Administration, and the DOE Division of Biological and Environmental Research, EES is conducting a broad-based research program into all electric and magnetic field effects from overhead transmission lines.

Randomline, Inc. -ID# 2863

1/78 - 1/80 $ 160,000

To investigate the feasibility of using an assay battery developed for evaluation of central nervous system (CNS) reactions, which has been used in microwave biological effects research to determine if there are any CNS effects from 60 Hz electric fields. If effects are found, determine the mechanisms by which such effects may have occurred.

General Electric Co. -ID# 5059

5/77 - 10/79 $1,469,754

Develop a sufficient data base on the effects and characteristics of electric fields and ion concentration from dc transmission lines to evaluate dc transmission as an alternative or complement to ac transmission.

Southwest Research Institute -ID# 2875

1/78 - 1/79 $ 456,386

Preliminary study of the behavioral and biological effects of high intensity electric fields on nonhuman primates.

Office of Naval Research -ID# 3030

2/78 - 2/79 $ 60,000

Management of the study of 60 Hz electric fields in the mammalion central nervous system.

Battelle Pacific N.W. Labs. -ID# 1830-6

2/76 - 9/79 $1,727,520

Establish a system for the exposure of small laboratory animals to 60 Hz electrical fields to determine whether there are any adverse biological effects.

National Bureau of Standards -ID# 6010/18

3/75 - 9/78 $ 150,000
(current year)

Establish requirements for traceability, performance criteria, and meter specifications for electric field measurement equipment.

National Bureau of Standards -ID# 6010/17

1/76 - 4/79 $ 180,000
(current year)

Investigate audible noise of ac and dc transmission lines, psychoacoustical analysis of noise spectrum and evaluation of human response to noise source.

Argonne National Laboratory -ID# 38-15

10/77 - 10/79 $ 378,000
(current year)

Investigate the effects of extremely low frequency fields (10 to 60 Hz.) in the circadian regulatory aspects of physiological and behavioral patterns in mammals. Results from this study will assist in the determination of allowable 60 Hz field strength for human populations in proximity to high tension electrical transmission lines and switchgear.

DC Biocage Design -ID# 3026

Complete preliminary experimental design to determine the biological effects of typical overhead HVDC systems on animals and design, fabricate and test an enclosure for housing small laboratory animals. For the experimental program which can accurately simulate the environment near dc lines.

Westinghouse Electric Co. -ID# 4092

6/78 - 12/79 $ 442,698

This project will assess the present available knowledge concerning the effect of carbon fibers on high voltage insulation including analysis of known field incidents, identify characteristics of carbon fibers as they affect high voltage insulation, institute a test program to quantify their effect and finally ascertain what remedial and protective actions are practical and applicable.

3. High Voltage DC Technology

HVDC networks, either as an overlay to existing ac systems, or in new arrangements to link load centers, offer considerable promise for more economic transmission of bulk power, enhanced systems stability, reduced environmental effects, and increased power delivery reliability. This activity concentrates on the terminal conversion equipment and on the development of a better understanding of the benefits and limitations to the wider application of dc transmission.

Los Alamos Scientific Laboratory -ID# 36-2

10/73 - 9/86 $1,215,000 (current year)

Develop and test a prototype dc superconducting power transmission line which will serve as a model for an actual system installation capable of transmitting electrical power in the multi-gigawatt level.

Pirelli Cable Corp. -ID# 5360

9/77 - 9/78 $ 126,115

Develop preliminary designs for the bottom cable and its connection to the submarine connector of the riser cable for OTEC application.

Simplex Wire and Cable Co. -ID# 5359

9/77 - 9/78 $ 198,328

Develop preliminary designs for the riser cable, submarine connector and the plant, and the integral cable suspension system.

National Bureau of Standards -ID# 6010/A021

12/75 - 9/78 $ 279,000
(current year)

Development of measurement methods which will lead to more effective use of high power semiconductor devices in applications for energy generation, transmission, conversion and conservation.

General Electric Co. -ID# 2065

11/75 - 9/78 $1,213,370

Establish the requirements for all the components of a prototype HVDC breaker, including specifications, designs and tests of the elements.

Massachusetts Institute of Technology -ID# 5003

9/78 - 9/79 $ 235,239

This project will provide theoretical and experimental output on how turbulence affects non-uniformity of deposition along an HVDC insulator string, how high current concentration "hot spots", aerodynamics, electrolysis and reactions produced by discharging affect the distribution of contaminant over each insulator, and how these factors combine to affect arc growth over each insulator unit and the entire string.

General Electric Co. -ID# 2152

3/75 - 6/79 $ 132,425

Development of an extruded solid dielectric insulation made specifically for dc operation. A number of candidate insulations will be developed, used in the manufacture of $\pm$ 100 kV cables, and tested (joint project with EPRI).

University of Wisconsin -ID# T-4047

4 months $ 9,300

Identify research areas in high voltage direct current (HVDC) power transmission for the nation's electric energy systems.

HVDC Gas Cable Technical Study -ID# 3108

This study is directed towards a total assessment of the technical and economical feasibility of utilizing a compressed gas insulated transmission line for an underground HVDC high capacity power delivery system.

Phelps Dodge Cable and Wire Corp -ID# 2093

9/76 - 12/79 $1,243,455

Design, development, manufacture, and full high voltage testing of an oil-impregnated laminar dielectric dc cable system and verification of its performance for operation in utility systems at $\pm$ 600 kV.

OTEC Power Integration -ID# 4083

The objectives of this project are twofold: (1) to identify inadequacies in planning capability to consider OTEC as a viable energy source, and (2) to back-out, using present state-of-the-art approaches (including heuristic planning techniques), the parameter values normally associated with energy sources that will make OTEC competitive in the time period 1985-2000.

4. Advanced Transformer and Generator Concepts

Transformers

The main objective is to significantly increase the power transformation capability per unit volume (kVA/m^3) while also improving their efficiency and reliability. This includes high capacity transformers, development of an inductive compensation device, and medium and distribution transformers.

Generators

Generators are the key link between advanced forms of energy technology and electrical power supply. The emphasis on generators is to advance technology to increase the energy density (less natural resource for a given amount of electrical energy producing capability), efficiency (more kilowatts available for consumption) and reliability. Advanced techniques will be developed in these areas to exploit these benefits.

General Electric Co. -ID# 2115

6/76 - 10/78 $ 321,500

Study the feasibility of using silicone fluids in transformers to replace environmentally inappropriate polychlorinated biphenyls (PCB).

General Electric Co. -ID# 2134

11/76 - 11/78 $1,138,656

Develop technologies associated with advanced transformer design concepts combining the application of sheet wound coils, compressed gas, polymeric film insulation, and separately sealed cooling system. The objective is to further develop and refine the technology required to produce a power transformer with increased MVA ratings, reduce size and weight, lower losses, and increased mechanical strength.

Westinghouse Electric Corp. -ID# 3058

24 months $ 410,000

To understand and to improve the power frequency dielectric breakdown strength of insulation structures in electrical terminal equipment for bulk power delivery systems.

1200 kV Shunt Reactor -ID# 3007

Explore new concepts for inductive shunt reactor designs for integration into a 1200 kV gas insulated substation.

Advanced Concepts for Transformers -ID# 3022

Seek advanced concepts for distribution, medium power and large power transformers for the nation's electric power transmission and distribution systems.

General Electric Co. -ID# 4097

8/78 - 2/80 $ 422,600

Develop and optimize the process necessary to produce a magnetic composite material made of amorphous metal flake and a suitable binder. The resultant technology when applied in motor stator yokes must provide potential benefits of increasing motor performance efficiency (reduced stator iron core losses), and opportunity for innovative motor designs.

Massachusetts Institute of Technology -ID# 2295/11

10/76 - 12/80 $4,200,000

Develop and demonstrate advanced design concepts for a superconducting generator. This will allow for an increase in the energy conversion efficiency of a very large synchronous generator in base load power plants, with reduced size and cost. Also, improvements in steady state and transient stability will allow more reliable and economic operation of power systems.

Burns & McDonald Engineering Co. -ID# 4536

9/77 - 10/78 $ 77,216

Assess the potential role of organic Rankine cycle bottoming systems for future power generation at small utilities.

5. Compact Stations

Higher voltage transmission, coupled with the need for transmitting large blocks of power from large central generating plants remote from population centers, makes another step up in transmission voltage inevitable. Air as an insulation medium for substations has technical constraints and practical limitations at 1200 kV and above. At these voltages, it is advantageous to change from air to compressed gas insulation because of size and height considerations.

Gas insulated substations need equipment specifically designed for use in a gas environment.

Power Technologies, Inc. -ID# 0860

12/77 - 12/79 $ 793,375

The main emphasis will be to determine the design and operational practicality of the high phase order transmission concept aiming to (1) increase the power carrying capability of circuits and rights-of-way, (2) provide line designs that are economically competitive with present line designs, and (3) ensure environmentally acceptability and effectively reduce the depletion of natural resources.

General Electric Co. -ID# 2070

11/75 - 5/79 $ 716,116

Develop lightning sensing and recording instruments.

Jet Propulsion Laboratory -ID# 1045

6/77 - 4/79 $ 817,000

This project calls for initiation of Phase II, to gather data on lightning surges that affect power distribution equipment. The effort provides for several tasks including, (1) prototype design and upgrading of transient recorders, (2) experiment design, (3) field tests of these recorders including the collection of data in conjunction with several utilities, (4) translation of the data from the field into engineering units and interpreting the data, and (5) the necessary technical and project management, for transient recorder development, and structuring and coordination of other tests.

Westinghouse Electric Corp. -ID# 5065

5/78 - 5/81 $2,587,000

Evaluate all system considerations that will affect the operation of a 1200 kV circuit breaker and evolve new interrupting and operating mechanisms that can be used to design a truly compact circuit breaker for applications in a 1200 kV gas insulated substation.

Rensselaer Polytechnic Institute -ID# 5102

9/77 - 9/79 $ 109,310

Develop methodology for electric field calculations by using diakoptic matrix reduction technique, thus making the field distribution study less costly for accuracy comparable to present methods.

Oak Ridge National Laboratory -ID# 26-3

11/75 - 10/78 $ 373,400
(current year)

Investigation of optimized gas mixtures for superior dielectric performance. This effort will examine the chemical and physical molecular properties of dielectric gases to quantify the insulating properties. Attention will also be given to any possible environmental effects that could arise as a result of the materials decomposition.

Westinghouse Electric Corp. -ID# 2051

6/75 - 9/78 $ 359,290

Investigation of dielectric strength of epoxy insulators for compressed gas insulated systems.

Charles T. Main, Inc. -ID# 2133

1/77 - 1/80 $1,918,913

Examine the design aspects of overhead transmission line support structure including all electrical, mechanical and economical requirements which could affect achievement of support systems of minimum environmental impact, and develop new transmission line support systems consistent with that goal.

Ohio Brass Co. -ID# 2072

1/76 - 3/79 $1,129,360

Design, test, and deliver a prototype surge protective device specifically designed for installation inside a 1200 kV ac gas insulated system and suitable for testing on an operating test facility.

General Electric Co. -ID# 2084

3/76 - 7/79 $ 995,900

Develop an instrumentation system for the measurement of line current and line potential and for the injection and reception of carrier current in a 1200 kV ac gas insulated power transmission system. The program will produce instrumentation specifically designed for and uniquely adapted to the geometry of the coaxial gas (SF_6) insulated system and having performance capability consistent with the needs of future systems.

Stone and Webster Engineering Corp. -ID# 2097

4/77 - 8/78 $ 160,000

Establish research priorities for further development work in transmission line and sub-station protection systems. The study is aimed at determining the benefits to be realized through more rapid fault clearing.

Westinghouse Electric Corp. -ID# T-031

6/78 - 5/79 $ 76,000

Verify and optimize the previously developed methods of determining power system losses from utility system data. Provide electric utilities with capability to assess system loss components under a variety of operating conditions.

University of Florida -ID# 3045

3/78 - 3/80 $ 246,992

Provide support of a DOE project on Lightning Protection of Distribution Systems by compiling basic information about the characteristics of lightning which strikes on or near the distribution lines chosen for detailed study in the Florida test. Computer modeling will be used to obtain a better understanding of the response of the system to the lightning.

Gould/ITE Imperial Corp. -ID# 3173

6/78 - 12/80 $ 972,000

Conduct system studies directed towards defining performance characteristics of a 1200 kV circuit breaker, and an isolator/ disconnect switch concept which is capable of energizing and de-energizing 1200 kV GIS components without exceeding 1.5 pu switching transients.

Gould/ITE Imperial Corp. -ID# 3015

20 months $ 350,000

Technical evaluation of a Superconducting Fault Current Limiter (SFCL) for application to electric power systems in order to provide higher short-circuit capabilities and equipment protection.

1200 kV Termination Study -ID# 3107

The objective of this project is to design, develop and deliver a 1200 kV prototype air to SF_6 gas bushing termination for integration into a gas insulated substation. The design must be economically attractive and it must exhibit improved electrostatic performance, acceptable temperature gradients and better mechanical integrity when compared with the gas/air terminations of typical ratings built with conventional technology.

Higher Distribution and Utilization Voltages -ID# 2866

Evaluation of the economics and energy efficiency of higher distribution and/or utilization voltages.

Commonwealth Associates, Inc. -ID# 4084

5/78 - 11/78 $ 47,897

To quantify the impact of high voltage overhead transmission options above 800 kV ac and 600 kV dc in improving the reliability and efficiency of the nation's electric power system.

POWER SUPPLY INTEGRATION SUBPROGRAM

Overview

The EES program for Power Supply Integration includes activities designed to enhance the commercialization and integration of dispersed generation, dispersed storage, load management and distribution automation technologies. This program also includes encouragement of the research, development and technical demonstration of advanced system control (operation) and system development (planning) technologies.

Subprogram Activities

The EES subprogram on Power Supply Integration has been formatted into five activities. A description of the projects under each activity, including a brief statement of objective, follows:

1. Load Management

This activity includes the research, development and technical demonstrations of alternative concepts of altering the actual or apparent pattern of customer's load to improve efficiency of the electric energy system. Load management can be accomplished in several ways, including the use of direct control over customer loads; the use of incentives (generally rate changes) to customers to change their consumption patterns; and by modifying the apparent pattern of customer load through the use of expanded interconnections and/or bulk power system energy storage.

Oak Ridge National Laboratory -ID# 26/PD1

1/77 - 9/82 $1,395,000 (Current Year)

Research and demonstration of electric "use" management (customer load management) concepts and technologies. Monitoring of non-DOE use management demonstrations. Management of national demonstration of behind the meter energy storage systems. Development of advanced analytical techniques to determine the cost/benefit of alternative load management concepts. Current/anticipated contracts include:

- technical demonstration of behind the meter heating and cooling energy storage for residences;
- technical demonstrations of alternative methods of controlled heat storage for a major commercial installation;
- advanced metering technology development;
- technical demonstration of industrial load management through direct load control;
- engineering feasibility study for a large scale system test of load management/distribution automation; and
- survey and description of non-DOE storage and control projects.

Systems Control, Inc. -ID# 1214

7/76 - 4/79 $ 501,473

Research and quantify the economic, reliability and capacity utilization effects of dispersed storage and generation on electric energy systems. The methodology will allow for evaluation of cost/benefit of alternative load management strategies.

Gilbert Associates, Inc. -ID# 2099

6/76 - 8/78 $ 251,487

Study potential for and cost effectiveness of direct utility control of customer loads by non-generating utilities, including analysis and description of alternative communicatio system for several sample rural and municipal utilities.

University of Florida -ID# 5624

10/77 - 9/78 $ 29,453

Produce one document including a detailed state-of-the-art survey of solar-electric conversion concepts, solar-electric conversion systems and the impact of solar-electric conversion systems on the electric utility system.

Commonwealth Associates, Inc. -ID# 2163

10/76 - 10/78 $ 150,000

Study the economic potential of lead acid batteries for large industrial load and non-generating utility systems.

Potomac Electric Power Co. -ID# 2085

5/76 - 10/79 $ 60,000

Demonstration and analysis of solar, load management system using off-peak heat pump in a residential application (joint project with EPRI).

2. Distribution Automation

Increasing load density higher distribution voltages, the addition of dispersed generation and storage technologies and other factors are contributing to an increase in the complexity of distribution facilities design and operation. This activity consists of R,D&D efforts required to deal with the increased complexity while enhancing the efficiency and reliability of the electric energy system.

Jet Propulsion Laboratory -ID# 1041

8/77 - 12/81 $ 400,000
(Current Year)

Provide technical management of DOE distribution communications modeling contracts including analytical activities relating these investigations to other DOE communications analysis work. Initiate a study to define the communications and control requirements for the integration of dispersed storage and generation into the power system and investigate the requirements for future distribution system control. Initiate a requirements analysis project to define the specific needs for communications and control technology and assist in defining the DOE program.

Current or anticipated contracts under this effort include:

- a study to investigate the concept of using satellite communication system for electric utility load management.
- state-of-the-art in dispersed storage and generation (DSG) and identification of communications, automation and control requirements for DSG.
- workshop to assist in defining the distribution automation and control program.

San Diego Gas and Electric Co. -ID# 1441

8/77 - 7/78 $ 55,000

Provide analysis of distribution automation and load management on the design of utility system operations centers.

General Electric Co. -ID# 2100

4/77 - 10/78 $ 295,932

Develop a parametric RF model of the communication characteristic of the distribution system. The model should be valid for frequencies from 1 kHz to 500 kHz.

DARCO, Inc. -ID# 5004

12/76 - 12/79 $1,273,588

Test and analyze the performance of a unique telephone-oriented communication system for Omaha Public Power District's distribution system. Capability will be demonstrated for load control through mass addressing, time-of-day metering, and system automation (in cooperation with EPRI).

Oak Ridge National Laboratory -ID# 26/PD

10/76 - 3/79 $ 276,000

Technical analysis and monitoring for field tests of communication systems for distribution automation. A review of local logic electronic systems for advanced metering and load control.

American Science and Engineering, Inc. -ID# 2120

8/76 - 1/80 $1,952,117

Demonstration of a distribution line carrier system that can be utilized for near-term LM objectives and mid-term system automation and control improvement. System will be tested with help of San Diego Gas and Electric Co. (in cooperation with EPRI).

Compu-Guard Corporation -ID# 2095

6/76 - 12/78 $ 322,622

Analyze noise sources on the distribution system and relate characteristics of noise to the potential to communicate on the feeder lines.

3. Dispersed Storage and Generation

The ability of the typical mix of baseload and peakload generators to meet fluctuating demand can be enhanced by energy storage and new generation concepts whose primary objectives are to shift the fuel consumption away from oil and gas presently consumed by diesel and turbine peakload generators.

Just as no single form of generation satisfies all generation needs, no single storage device will satisfy all storage requirements. The principal project under development for generation is the 4.8 MW fuel cell power plant. This project is in the transition phase from R, D&D to commercialization and is the subject of a team planning effort. The Dispersed Storage activity will provide a range of storage options to provide an optimum storage and generation mix.

Argonne National Laboratory -ID# 38-ST

7/78 - 7/79 $ 500,000

Develop advanced lead acid battery for utility load levelling application, having longer life (20 years), lower cost ($30/kwh) and reduced emissions, as compared with the state-of-the-art technology.

Arthur D. Little, Inc. -ID# 5061

7/77 - 5/78 $ 107,140

Develop a commercialization plan for battery storage systems for electric utilities.

Middle South Services, Inc. -ID# 5048

9/77 - 9/79 $ 506,870

Compressed air storage demonstration. Perform preliminary plant design and site exploration studies for a utility compressed air energy storage system using a solution mined salt cavern (in cooperation with EPRI and MSS).

Battelle N.W. Laboratory -ID# 1830/5

10/77 - 10/78 $ 350,000

Develop compressed air energy storage (CAES) stability criteria for reservoirs (aquifiers, salt caverns and hard rock mined caverns) subjected to daily cycling of temperature, pressure and humidity.

Potomac Electric Power Co. -ID# 5047

9/77 - 9/79 $1,977,367

Development of site-specific designs for utility applications of compressed air and underground pumped hydro-energy storage demonstration plants utilizing hard rock mined caverns (in cooperation with EPRI and PEPCO).

Mitre Corporation -ID# 5025

9/77 - 3/78 $ 94,637

Estimate the potential national market for lead/acid battery plants for electric utilities and the identification of requirements for successful commercialization.

Energy Development Associates -ID# T-4041

7/78 - 12/80 $9,000,000

Develop a commercial battery configuration for widespread utility applications, in order to increase the utilization of existing base load power plant facilities and decrease reliance on imported oil. The particular objective is to procure a zinc-chlorine battery for a test of its suitability for utility operation in the BEST facility.

Argonne National Laboratory -ID# 38-14

10/77 - 10/78 $ 160,000 (current year)

Participate in Battery Energy Storage Test (BEST) Facility advisory group activities, design catalytic recombinative device for lead-acid battery and develop stibine and arsine monitoring kit.

Argonne National Laboratory -ID# 38-13

10/77 - 10/78 $ 500,000

Engineering development of a lithium/iron sulfide battery module for stationary energy storage.

Public Service of Indiana, Inc. -ID# 2159

30 months $1,350,000

Perform preliminary plant design and site exploration studies for a utility compressed air energy storage (CAES) system using an aquifier storage field (in cooperation with EPRI and PSI).

Public Service Electric and Gas Co. of New Jersey, Inc. -ID# 2857

6/76 - 6/81 $5,000,000

Design, construction, and validation of a 3 bay (2.5 Mw, 10.0 Mwh battery per bay) test facility to evaluate the performance of advanced batteries and advanced ac/dc converter techniques for load leveling in an electric power system environment. Test performance of batteries, converter equipment controls and impact of an electric power system grid on batteries following laboratory development prior to full scale demonstration (in cooperation with EPRI and PSEG).

Gilbert Associates -ID# 2163

9/76 - 12/77 $ 100,260

Determine potential near-term applications of large-scale lead/acid battery converter systems for non-generating utility and industrial peak load use.

United Technologies Corp. -ID# 2122

9/76 - 6/78 $ 259,082

Evaluate inverter-rectifier technology for battery energy storage applications based on FCG-1 (Fuel Cell Generator) inverter technology.

Westinghouse Electric Corp. -ID# 2117

10/76 - 3/78 $ 230,000

Develop prototype static emergency forced commutation circuits, and define requirements for dc circuit breakers and dc fuses required for application in the Battery Energy Storage Test (BEST) facility.

United Technologies, Corp. -ID# 1016

10/77 - 3/81 $2,750,000

This procurement will provide spare parts for the demonstration of the 4.8 MW Fuel Cell power plant at Con Edison, New York.

Consolidated Edison Co. of New York -ID# 5018

10/77 - 3/81 $3,250,000

Selection of a Host Utility for implementation of the 4.8 MW Demonstrator module delivered under separate contract. The implementation will serve to define configuration, modes of application, performance and preliminary cost characteristics

of a fuel cell generator in a normal operating environment. The results of the implementation will provide the criteria for design, fabrication and functional assignment (spinning reserve, base, intermediate or peaking loads) of fuel cell power plants which maximize efficiency and minimize cost (in cooperation with EPRI).

United Technologies Corp. -ID# 2102

6/76 - 3/79 $24,947,666

This contract is for delivery of an FCG-1 (Fuel Cell Generator) Module Demonstrator (4.8 MW) to be evaluated in an electric utility network, under a separate contract. It will be used to define the modes of application, performance and cost characteristics in a normal operating environment. The results of the demonstration will provide the criteria for design, fabrication and functional assignment which will maximize efficiency and energy conservation and minimize cost. Operational testing at UTC will be limited to check out of components prior to transfer to a host utility (in cooperation with EPRI).

Illinois Institute of Technology -ID# 4531

9/77 - 2/79 $ 200,726

Perform research which will lead to conservation of energy through management and utilization of waste heat from steam condensers of large electric power plants.

Public Service Electric & Gas Co. of New Jersey, Inc. -ID# 4722

5 years $2,350,000

Arrive at a meaningful comparison of the ultimate costs, degrees of operating flexibility, and environmental and safety impact, among the advanced batteries, by conducting a series of balance-of-plant cost design studies, battery manufacturing cost studies, environmental and safety assessments, and further evaluation of credits associated with the unique features combined in a battery storage plant.

Storage Battery Electric Energy Demonstration (SPEED) -ID# T4023

Accelerate the commercialization of batteries for bulk energy storage by addressing the power system issues of system planning, system operation, system interaction, and market acceptability in a battery demonstration plant.

Central Station Thermal Storage Preliminary Design -ID# 4081

6/78 - 6/81 $2,900,000

Interagency agreement with NASA to provide for the project management and procurement of the preliminary design phase of the central station thermal storage system integration and field test project.

4. Complex Systems Control

Control systems are sought which not only detect incipient emergencies but which also propose possible corrective actions. The ultimate goal is the development of a control system which adapts itself to alternate modes of operation automatically. Such computerized control systems will almost certainly have to be designed with the help of other computers. Yet, to date, nobody has produced either the theory, the mathematical formulations, or the methodology needed to reconcile the normal dynamics of an ever-changing power system, the likely disturbances, the possible sensor errors, and the diverse performance goals so that a designer can be sure which design parameters are most important.

This activity includes the R, D and D efforts directed to encourage the development and implementation of the concepts and technological tools required for increasingly complex systems control. Topic areas are highlighted.

EMERGENCY OPERATING STATE CONTROL

Washington University -ID# 2073

10/75 - 10/78 $ 416,895

Study feasibility of using the concept of local system equilibrium and local control actions and information as the basis for a power system emergency state control regime.

Wayne State University -ID# 2074

1/76 - 1/79 $ 446,992

A simulation-based demonstration of the suitability of a new control strategy, the Optimal-Aim Strategy, for on-line use to augment system transient stability.

Massachusetts Institute of Technology -ID# 2075

1/76 - 1/79 $ 445,093

The development of techniques to help restore frequency and load after a major disturbance such as loss of generation, tie-line support, or load, and the evaluation of these techniques on a laboratory physically-based model of a power system.

Systems Control, Inc. -ID# 2076

1/76 - 1/79 $ 300,062

Consider problems of defining objectives for emergency state control and developing control algorithms for achieving these objectives. Attention will be focused upon the problem of maintaining transient stability during an emergency state.

MODELING AND SIMULATION

Purdue University -ID# 4603

6/78 - 4/80 $1,935,500

Establish the capability for the simulation and study of large power systems that will allow the verification and enhancement of energy saving technologies and new power system control techniques without the delays, expense or risk of performing experiments on an actual power system.

Purdue University -ID# 4206

1/77 - 12/79 $ 517,818

Models will be developed for storage conversion system for application in existing stability studies. In addition, the interaction between the storage device and the AC system will be studied. The other focal point is a new approach to determine dynamic equivalents to power systems through on-line measurements.

General Electric Co. -ID# 5566

9/77 - 8/79 $ 181,889

Determine and demonstrate the applicability of a mathematical technique, known as singular perturbation to long-term system dynamic analysis, to the general area of planning and operation of large interconnected electric energy supply systems.

NORMAL OPERATING STATE CONTROL

Systems Control, Inc. -ID# 2118

6/77 - 12/80 $ 826,225

Develop a coordinated control policy which effectively utilizes the full potential of centralize utility operation and control on improved software automatic generation control package for implementation on a utility system.

Washington University -ID# 4305

3/77 - 2/79 $ 179,456

This project consists of extending, augmenting and evaluating a newly formulated economic generation control strategy which was structured on the basis of highly idealized models of power system components and loads.

Arthur D. Little, Inc. -ID# 5049

7/77 - 9/78 $ 130,199

Develop a method of determining the optimum use patterns for energy storage devices used by electric utilities.

LOAD MODELING

Boeing Computer Service, Inc. -ID# 5111

11/77 - 11/79 $ 371,272

Develop a methodology for constructing load models for power systems.

Georgia Institute of Technology -ID# 5109

11/77 - 11/80 $ 201,189

Specify model components, hierarchies and data base requirements, derive representative steady-state and transient models for electrical devices, build a simulator model, and develop and demonstrate a validation methodology based on available human use pattern for each device.

Texas A & M University -ID# 5057

9/77 - 9/80 $ 290,125

Develop a physically-based methodology for load modeling. The scope of the research includes the development of short-term, load-demand models and load-response models using a stochastic, deductive approach.

General Electric Comopany -ID# 5112

1/78 - 6/80 $ 779,425

Develop a new, physically based load modeling methodology which will contribute towards the development of the broad understanding of the load which is needed. There are 3 key elements including, the hypothesized model structure, the demand data analysis, and the response model development.

Oregon State University -ID# 5110

9/77 - 9/79 $ 68,983

Establish a methodology for depicting the load in electricity supply networks using a parametric stochastic differential model.

MULTI-TERMINAL DC SYSTEMS

DC Systems -ID# 1055

To formulate strategies and develop techniques to integrate and control multiterminal High Voltage DC systems which are part of a larger electric power system.

PLANT CONTROL

Power Plant Control -ID# 1056

To formulate and develop advanced concepts for the automatic control of electric power generating plants.

OPERATIONS PLANNING

Operation Planning -ID# 4070

Develop techniques which will advance the state-of-the-art for power system operation scheduling, over periods of months down to hours, involving the development of probabilistic techniques for maintenance and production scheduling and unit commitment.

5. Large Scale Systems Development

This activity addresses the need to develop improved planning techniques, and includes three elements,

SYSTEMS STRUCTURING,
the development of planning methods which can be applied to the optimal arrangement of the electric utility system.

SYSTEMS ANALYSIS,
concerned with how all the components in the network affect each other in a dynamic situation, and

FORECASTING AND PLANNING,
advancing the state-of-the-art to quantify long term load forecasting and related problems.

Topic areas are highlighted.

ORGANIZATIONAL FORMS FOR LARGE SCALE SYSTEMS

Boeing Computer Services -ID# 2876

6/78 - 6/79 $ 93,146

The objective of this project is to characterize the solvability of large scale descriptor systems, i.e., a system represented by a set of simultaneous implicit equations.

Massachusetts Institute of Technology -ID# 2087

1/76 - 1/79 $ 383,700

Develop methodology, theory, and algorithms necessary to design decentralized organizational forms for large interconnected power systems.

University of Illinois -ID# 2088

3/76 - 3/79 $ 390,312

Enlarge the scope of decentralized control procedures by extending multi-person game and team theory to incorporate the use of multiple, non-common models by decision makers in large scale system theory.

SRI International -ID# 2089

6/76 - 10/78 $ 90,000

Reformulate the problem of the "coordination of hierarchical systems" along normative lines, and bring the insights of several different disciplines to bear on the problem formulation.

Systems Control, Inc. -ID# 2090

3/76 - 2/79 $ 286,868

Perform research on a descriptor variable approach to modeling and optimization of large-scale systems based on a new methodology for the representation of large scale dynamic systems.

University of Michigan -ID# 2091

3/76 - 3/79 $ 136,899

Develop a concept of generalized independence from which general theory of large scale system decomposition may evolve.

Drexel University -ID# 2092

3/76 - 3/79 $ 170,835

Develop methodology for application of a method of averaging to large systems analysis and evaluate the effectiveness of averaging methods.

Lawrence Livermore Lab. -ID# 48-1

10/77 - 10/78 $ 140,000

Research on this project is being conducted with the goal to extend mathematical systems theory by developing a theory of modeling and simulation. The immediate objective has been to formulate a framework in which modeling and simulation problems can be precisely discussed.

ENERGY STORAGE EVALUATION METHODS

Case Western Reserve University -ID# 2124

5/77 - 5/80 $ 406,227

Recent and proposed developments in energy storage technology will greatly affect the traditional patterns of power system planning. This project will determine required changes to existing methods and/or develop new methods with energy storage devices. The primary objective for this research is to advance the state-of-the-art used for carrying out certain of the evaluations necessary to incorporate energy storage devices into the power planning function.

Systems Control, Inc. -ID# 5050

7/77 - 7/80 $ 451,847

Develop a generalized and integrated set of models to describe energy storage devices being developed to properly represent their operating mode, and to evaluate the impact on production costs, reserve requirements, system reliability, load following, and other important factors.

NETWORK ANALYSIS

McGill University -ID# 5011

1/77 - 12/79 $ 129,914

Analyze and explicitly characterize those conditions under which an electric power system is secure. The term secure has two implications. First, is the feasibility requirement which denotes the absolute limitations of a power network to transmit power from one point to another while maintaining specified voltage, generation and load levels. Second, that no equipment overload occur for any of a reasonable number of foreseeable operating conditions.

Purdue University -ID# 4345

5/77 - 10/79 $ 187,386

This project is concerned with investigating, refining, and extending the range of applicability of the stochastic power flow method. This method is used to perform statistical analysis of bus voltages and line loadings of an electric power system.

Drexel University -ID# 4491

7/77 - 6/79 $ 148,000

Develop new methods for planning, operating, and maintenance scheduling for electric energy systems.

SYSTEM EFFECTIVENESS ANALYSIS

Systems Control, Inc. -ID# 5106

9/77 - 9/80 $ 542,371

Demonstrate that the proposed conceptual framework and the resulting quantitative theory of large scale system effectiveness integrates the four concepts (performance, availability, cost and worth) and leads to a general theory needed to transform a physical electric power system into a representative energy service delivery network.

SRI International -ID# 5107

9/77 - 3/79 $ 175,132

Determine what measures of the cost of large-scale electric energy systems can reasonably be defined, and what measures of the worth of large scale electric energy systems can be defined considering the practical problem of quantifying the tolerances of the various classes of customers to system performance and availability.

University of California-Berkeley -ID# 5105

9/77 - 9/80 $ 299,600

This research concerns the development of a conceptual framework for assessing the effectiveness of an electric energy system and the further development of modern mathematical theory of reliability to provide analytical tools for power system reliability evaluations.

ECON, Inc. -ID# 5008

10/77 - 9/79 $ 416,620

Perform research on measures of large-scale system effectiveness and set forth a broad theoretical framework for analyzing and quantifying large-scale electric power system performance, availability, cost and worth, and outline implementation plans to test the theory.

Texas A & M University -ID# 5104

9/77 - 9/79 $ 379,857

Determine what types of measures can be reasonably defined to describe both the steady-state and dynamic performance of a system, using system models of proper scope and level of abstraction to facilitate relating the measures to the appropriate physical characteristics of the system.

DISTRIBUTION PLANNING

Systems Control, Inc. -ID# 1845

1/78 - 6/79 $ 240,388

Develop concepts and methods needed in planning the expansion of distribution systems. In view of the impact of both new hardware technology and operating concepts, better tools are needed to assess competing expansion plans.

Carnegie-Mellon University -ID# 4538

9/77 - 9/80 $ 318,792

Develop an advanced integrated set of models for distribution planning, which recognize dispersed storage and generation technologies.

COMPLEX SYSTEM STABILITY

University of Santa Clara -ID# T-4064

9/77 - 9/80 $ 246,918

Formulate and develop advanced concepts for the stability of complex electric energy systems.

University of Florida -ID# 4050

6/78 - 2/80 $ 47,088

The objective is to determine the state-of-the-art of electric utility functional modeling. Using this assessment as basis, the EES Division intends to develop a research program.

EES Research Reports Available Through National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virignia 22161 (Note #1)

Pub. Date	
10/75	CONF-750867 Systems Engineering for Power: Status and Prospects ($10.60).
10/75	NBSIR-75823 Helium Research in Support of Superconducting Power Transmission ($4.75).
2/76	COO-2552-6 Assessment and Study of Existing Concepts and Methods of Cryogenic Refrigeration for Superconducting Transmission Cables ($7.75).
3/76	CONS-1826-1 A New Class of Additives to Inhibit Tree Growth in Solid Extruded Cable Insulation ($6.75).
4/76	CONS-2551-1 Research and Development Efforts Relative to Superconducting Materials ($5.00).
5/76	NBSIR-76-1054 An Appraisal of Tests and Standards for the Evaluation of Electrical Insulating Fluids ($5.00).
6/76	CONS-2549-1 Development of Nb3Sn Conductor for AC Superconducting Power Transmission Cables ($5.00).
6/76	CONS-2522-2 Improved Superconducting for Transmission Line Applications, Phase II ($7.50).
6/76	CONS-2053-1 Coupling and Corona Effects Research Plan for Transmission Lines ($7.75).
6/76	CONS-1061-1 Methods of Refrigeration for Superconducting Power Transmission Cables ($7.75).
8/76	CONS-2050-1/1 (Executive Summary); CONS-2050-1/2 (Task Reports); CONS-2050-1/3 (Appendix) Analysis and Forecast of Electrical Distribution System Materials (1/1-$3.50; 1/2-$9.25; and 1/3-$9.75).
8/76	EPRI-TD-229 Development of an Evaporation-Cooled Underground Transmission System (CONS-212) ($9.25).
8/76	CONS-2155-1 Synchronous Transmission Circuit Breaker Development Breaker ($7.50).

Note #1. Price of printed copy, when known, shown in parenthesis. Microfiche: $3.00.

7/76 ERDA E(49-18)-1422 Investigation of Mechanism of Breakdown in XLPE Cables.

9/76 ERDA-76-150/1 (Plant, Component, and Control Description); ERDA-76-150/2 (Open Loop Transient Tests); ERDA-76-150/3 (Closed Loop Transient Tests) Power Plant Data Base Philadelphia Electric Company Cromby No. 2 Unit (1/1-$9.25; 1/2-$16.25, 1/3-$21.25).

9/76 ERDA-76-151 Modeling and Simulation of Hanford K-Area Boiler-Turbine-Generator System ($13.50).

9/76 ERDA-76-152 Model Validation Using Time and Frequency Domain Error Measures ($5.00).

9/76 CONS/2062-1 Measurements on Insulating Materials at Cryogenic Temperature ($6.00).

9/76 CONS-2157-1 Impulse Strength of Distribution Transformers Under Load ($5.00).

10/76 ERDA-76/160 Comparative Cost Study of the Processes for Producing Niobium-Tin (Nb3Sn) Superconducting Tapes for their Application to Power Transmission Lines WA-76-9439 ($5.50).

10/76 CONS-2114-2 Study of the Manufacturing Costs of Lead-Acid Batteries for Peaking Power ($5.00).

10/76 CONS/1205-1 Engineering Study of a 20 MV Lead-Acid Battery Energy Storage Demonstration Plant ($8.00).

12/76 ORNL/TM-5713 High Voltage Research (Breakdown Strengths of Gaseous and Liquid Insulators), Second Quarterly Report.

12/76 CONS-2114-1 Executive Summary Study of Lead-Acid Battery Systems for Peaking Power ($3.50).

12/76 CONS/NSF/42-1 Preliminary Feasibility Evaluation of Compressed Air Storage Power Systems Volume I ($11.00).

12/76 CONS/NSF/42-1 Preliminary Feasibility Evaluation of Compressed Air Storage Power Systems Volume II Appendices ($8.00).

1/77 CONS-1168-1 Critical Analysis of European Load Management Practices ($4.50).

2/77 CONS/3800-1 Helium Research in Support of Superconducting Power Transmission ($5.00).

2/77 CONS/2066-1 Report of Feasibility of High Phase Order Transmission ($5.50).

3/77 CONS/2107-1 Sampling Plans for Lightning Surges Test Program ($6.00).

5/77 CONS/3800-2 Measurement Techniques for High Power Semiconductor Materials and Devices ($5.00).

5/77 CONS/1420-1 Superconducting Cable System ($4.50).

9/76 CONS/1830-1 Biological Effects of High Strength Electrical Fields on Small Laboratory Animals ($5.00).

9/77 CONS/1830-2 Biological Effects of High Strength Electric Fields on Small Laboratory Animals.

4/78 HCP/T-1830-03 Biological Effects of High Strength Electric Fields on Small Laboratory Animals (Write directly to E.E.S Division for this report).

9/76 CONS/2063-1 Dynamic Load Model Study For Overhead Transmission Lines ($5.50).

6/77 ORO/3509-1 Survey of Utility Load Management and Energy Conservation Projects ($4.00).

12/77 HCP/T-2063/2 Dynamic Load Model Study for Overhead Transmission Lines ($4.00).

12/77 HCP/T-6010/E2 Preliminary Tests of Psychoacoustic Facilities and Techniques for Studying the Human Response to Transmission Line Audible Noise ($4.50).

12/77 ORNL/Sub-77/13509/2 Survey of Utility Load Management and Energy Conservation Projects ($9.50).

12/77 DOE/EA-0001 Environmental Assessment Battery Energy Storage Test (BEST) Facility ($4.00).

1/78 HCP/T-2068/1 Contamination Flashover Mechanisms of DC Transmission Line Insulators.

1/78 HCP/T-5468/1 Regional Power Systems Planning: A State of the Art Assessment ($9.75).

Note #2. DOE publications may be requested from EES Division.

11/77 EPRI-EL-147, ERDA E(49-18)-1568, Free and Forced Convective Cooling of Pipe-Type Electric Cables.

11/77 HCP/T-6010 E1, AC Transmission Line Field Measurements.

1/78 EPRI EL-220, ERDA E(49-18)-1556, Study of Gas Dielectrics for Cable Insulation.

2/78 HCP/T-2055/1 Evaluation of the Economical and Technological Viability of Various Underground Transmission Systems for Long Feeds to Urban Load Areas.

2/78 HCP/T-2064/1 Design of a Power System Simulator ($8.00).

9/77 ORNL/TM-5941, Cryogenic Dielectrics.

3/78 HCP/ET (2857)-1, Economic Assessment in the Utilization of Lead-Acid Batteries in Electric Utility Systems.

10/76 EPRI/ERDA E(49-18)-2126, Development of an Evaporation Cooled Underground Transmission System.

6/77 CONS/2104-1 Resistive Cryogenic Cable - Phase III.

10/77 CONS/2057-1 Developoment of an Improved Extruded Dielectric Cable Rated 230 kV.

3/78 EPRI-EL-605, Project 7829, ERDA-E(49-18)-1827, A Dynamic Model for Computer Control of the Extrusion of Solid Dielectric Cable.

3/78 EPRI-EL-606, Project 7818, ERDA-E(49-18)-1561, The Development of a High Voltage DC Cable.

3/78 HCP/T-2110/1, Design, Development, Fabrication and Testing of an Operational Prototype Surge Protective Device.

2/78 DOE/ET-0004, Load Management on the Electric Power System.

2/78 DOE/ET-0012/1 Systems Engineering for Power, January 1978, Program Report.

5/77 ERDA E(49-18)-1827 - Volume I - Development of Extruded Dielectric Underground Transmission Cables Rated 138 kV, 230 kV and 345 kV.

5/78 HCP/T 2077-01 Superconducting Cable System